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Suspended Patch Antennas With Electromagnetically Coupled Inverted Microstrip Feed for Circular Polarization

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SUSPENDED PATCH ANTENNAS WITH ELECTROMAGNETICALLY COUPLED INVERTED MICROSTRIP FEED FOR CIRCULAR POLARIZATION

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Abstract: The paper demonstrates a suspended nearly square patch antenna with offset feed and a square patch antenna with truncated corners for circular polarization. The antennas are excited by an electromagnetically coupled inverted microstrip feed. In addition a new transition between conventional microstrip and inverted microstrip is proposed. The measured results include the axial ratio and the impedance bandwidth of the antennas.

I. INTRODUCTION

Future space borne microwave/millimeter-wave systems such as radars, radiometers and communication systems will require printed antennas which have high gain, high efficiency, low profile, light weight and low cost. Printed antenna arrays with conventional microstrip corporate feed suffer from excessive conductor loss at millimeter-wave frequencies [1], [2]. The high conductor loss reduces the gain and the efficiency of the array. In addition, the thick dielectric substrate required for bandwidth contributes substantially to the mass to the array [3]. The conductor loss can be reduced by constructing the feed network using low loss transmission media such as, inverted microstrip [1], [2], suspended microstrip [4] and suspended substrate stripline [5]. Since, the dielectric substrate in these transmission media is very thin there is considerable saving in mass also. A suspended patch antenna excited by an electromagnetically coupled inverted microstrip feed at S-Band frequency has been demonstrated in [6]. In this paper first, a suspended nearly square patch antennas with offset feed, second, a suspended square patch antenna with corners truncated for circular polarization is demonstrated. Both antennas are electromagnetically coupled to inverted microstrip feed and operate at K-Band frequencies. The advantages of the above feeding technique include significantly lower attenuation and easier fabrication due to wider strip width for a given characteristic impedance (Z_0) [7]. Third, a novel transition from conventional microstrip to inverted microstrip is demonstrated. This transition will allow fast and inexpensive characterization of the above antennas at millimeter-wave frequencies using coplanar waveguide (CPW) RF probes. The measured results include the axial ratio and the impedance bandwidth of the antennas.

II. ANTENNA CONSTRUCTION

A schematic of a suspended nearly square patch antenna electromagnetically coupled to an inverted microstrip offset feed for circular polarization is shown in Figure 1. The inverted microstrip line consists of a thin dielectric substrate (RT/duroid 5880, $\varepsilon_r = 2.22$) of thickness h (0.01 inch) separated from a ground plane by an air gap of height g (0.01 inch). The strip conductor of width

W_i ($\approx$ 0.045 inch for Z_0 = 50 Ω) is situated on the lower surface of the dielectric substrate facing the ground plane. The length and width of the patch are L_1 and L_2 respectively. The feed offset and the overlap between the patch and the feed are indicated as d and S respectively in Figure 1. Next, a suspended square patch antenna (L x L) with two corners truncated (ΔL) is shown in Figure 2. The feed is symmetrically located and the overlap between the patch and the feed is S.

III. MICROSTRIP-TO-INVERTED MICROSTRIP TRANSITION

A back-to-back conventional microstrip-to-inverted microstrip transition is shown in Figure 3. In this transition the strip conductors of the microstrip and the inverted microstrip overlap and power is transferred through electromagnetic coupling. A pair of coplanar waveguide (CPW) pads are provided at the microstrip input and output ports for characterization using RF probes.

IV. EXPERIMENTAL RESULTS

The measured axial ratio of the suspended nearly square patch antenna with offset fed is shown in Figure 4. The 3 dB axial ratio bandwidth is about 1.59 percent. The measured return loss of the suspended square patch antenna with truncated corners is shown in Figure 5. The −10.0 dB return loss bandwidth is about 7.0 percent. Additional measurements including radiation patterns, return loss and axial ratio of the antennas and the insertion/return loss of the transition are in progress.

V. CONCLUSIONS

The paper demonstrates a suspended nearly square patch antenna with offset feed and a suspended square patch antenna truncated corners for circular polarization. The antennas are excited by an electromagnetically coupled inverted microstrip feed and operate at K-Band frequencies. The measured results include the axial ratio and the impedance bandwidth of the antennas.

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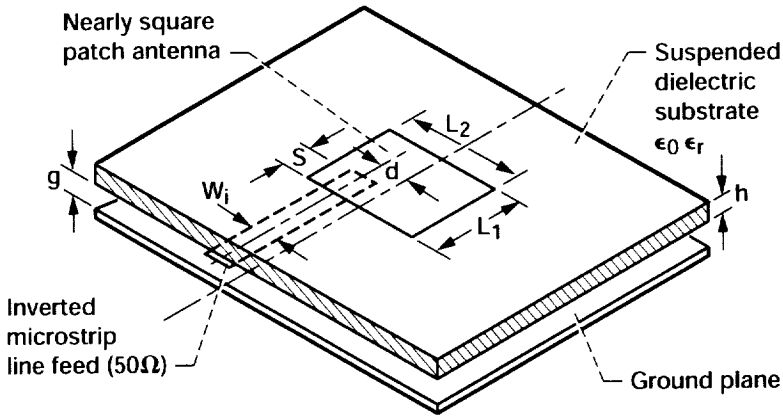

Figure 1.—Schematic of a nearly square patch antenna electromagnetically coupled to an inverted microstrip line offset feed for circular polarization. Dimensions in inches are L_1 = 0.215, L_2 = 0.206, S = 0.049, d = 0.011.

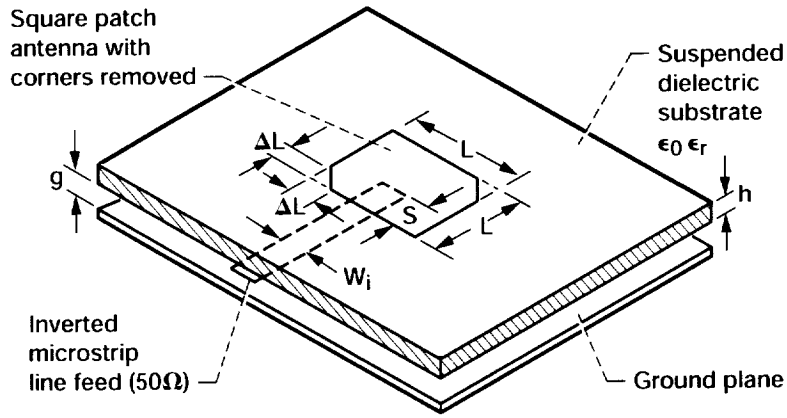

Figure 2.—Schematic of a square patch antenna with corners removed and electromagnetically coupled to an inverted microstrip line feed for circular polarization. Dimensions in inches are L = 0.207, ΔL = 0.04, S = 0.125.

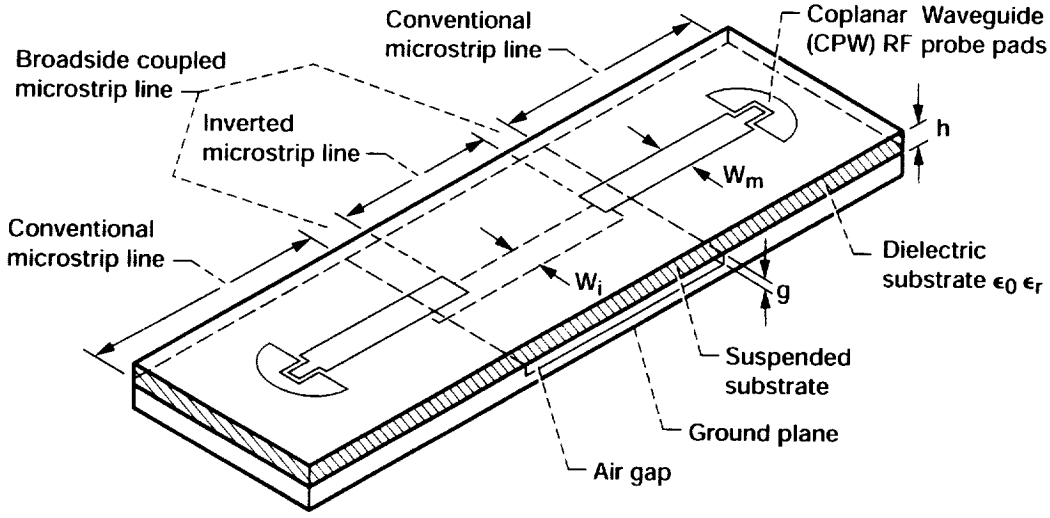

Figure 3.—Schematic of a back-to-back conventional microstrip-to-inverted microstrip transition. W_m = 0.03 inches.

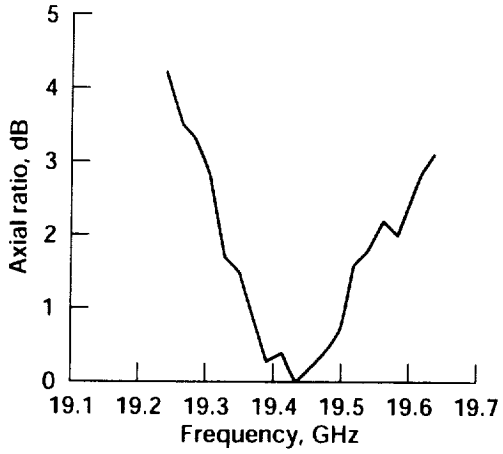

Figure 4.—Measured axial ratio of the nearly square patch antenna with offset feed.

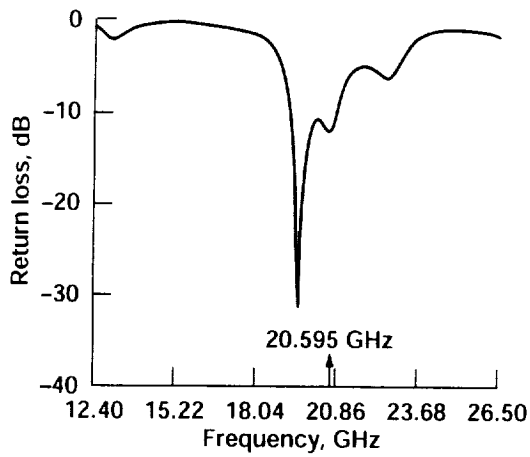

Figure 5.—Measured return loss of the square patch antenna with corners removed.

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13. ABSTRACT ***(Maximum 200 words)***

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